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an aluminum wall or cover, the thickness of the steel shield is used to determine the minimum free distances.

(p) The following static pressure test must be performed on each prototype design of explosion-proof enclosures containing high-voltage switchgear prior to the explosion tests. The static pressure test must also be performed on every explosion-proof enclosure containing high-voltage switchgear, at the time of manufacture, unless the manufacturer uses an MSHA accepted quality assurance procedure covering inspection of the enclosure. Procedures must include a detailed check of parts against the drawings to determine that the parts and the drawings coincide and that the minimum requirements stated in part 18 have been followed with respect to materials, dimensions, configuration and workmanship.

(1) *Test procedure.* (i) The enclosure must be internally pressurized to at least the design pressure, maintaining the pressure for a minimum of 10 seconds.

(ii) Following the pressure hold, the pressure must be removed and the pressurizing agent removed from the enclosure.

(2) *Acceptable performance.* (i) The enclosure during pressurization must not exhibit—

(A) Leakage through welds or casting; or

(B) Rupture of any part that affects the explosion-proof integrity of the enclosure.

(ii) The enclosure following removal of the pressurizing agents must not exhibit—

(A) Visible cracks in welds;

(B) Permanent deformation exceeding 0.040 inches per linear foot; or

(C) Excessive clearances along flame-arresting paths following retightening of fastenings, as necessary.

[67 FR 10999, Mar. 11, 2002; 69 FR 68078, Nov. 23, 2004; 69 FR 70752, Dec. 7, 2004]

§ 18.54 High-voltage continuous mining machines.

(a) *Separation of high-voltage components from lower voltage components.* In each motor-starter enclosure, barriers, partitions, and covers must be provided and arranged so that personnel can test and troubleshoot low- and medium-

voltage circuits without being exposed to energized high-voltage circuits. Barriers or partitions must be constructed of grounded metal or nonconductive insulating board.

(b) *Interlock switches.* Each removable cover, barrier, or partition of a compartment in the motor-starter enclosure providing direct access to high-voltage components must be equipped with at least two interlock switches arranged to automatically de-energize the high-voltage components within that compartment when the cover, barrier, or partition is removed.

(c) *Circuit-interrupting devices.* Circuit-interrupting devices must be designed and installed to prevent automatic re-closure.

(d) *Transformers supplying control voltages.* (1) Transformers supplying control voltages must not exceed 120 volts line to line.

(2) Transformers with high-voltage primary windings that supply control voltages must incorporate a grounded electrostatic (Faraday) shield between the primary and secondary windings. Grounding of the shield must be as follows:

(i) Transformers with an external grounding terminal must have the shield grounded by a minimum of No. 12 A.W.G. grounding conductor extending from the grounding terminal to the equipment ground.

(ii) Transformers with no external grounding terminal must have the shield grounded internally through the transformer frame to the equipment ground.

(e) *Onboard ungrounded, three-phase power circuit.* A continuous mining machine designed with an onboard ungrounded, three-phase power circuit must:

(1) Be equipped with a light that will indicate a grounded-phase condition;

(2) Have the indicator light installed so that it can be observed by the operator from any location where the continuous mining machine is normally operated; and

(3) Have a test circuit for the grounded-phase indicator light circuit to assure that the circuit is operating properly. The test circuit must be designed

so that, when activated, it does not require removal of any electrical enclosure cover or create a double-phase-to-ground fault.

(f) *High-voltage trailing cable(s)*. High-voltage trailing cable(s) must conform to the ampacity and outer dimensions specified in Table 10 of Appendix I to Subpart D of this part. In addition, the cable must be constructed with:

(1) 100 percent semi-conductive tape shielding over each insulated power conductor;

(2) A grounded metallic braid shielding over each insulated power conductor;

(3) A ground-check conductor not smaller than a No. 10 A.W.G.; or if a center ground-check conductor is used, not smaller than a No. 16 A.W.G. stranded conductor; and

(4) Either a double-jacketed or single-jacketed cable as follows:

(i) *Double jacket*. A double-jacketed cable consisting of reinforced outer and inner protective layers. The inner layer must be a distinctive color from the outer layer. The color black must not be used for either protective layer. The tear strength for each layer must be more than 40 pounds per inch thickness

and the tensile strength must be more than 2,400 pounds per square inch.

(ii) *Single jacket*. A single-jacketed cable consisting of one protective layer. The tear strength must be more than 100 pounds per inch thickness, and the tensile strength must be more than 4,000 pounds per square inch. The cable jacket must not be black in color.

(g) *Safeguards against corona*. Safeguards against corona must be provided on all 4,160-voltage circuits in explosion-proof enclosures.

(h) *Explosion-proof enclosure design*. The maximum pressure rise within an explosion-proof enclosure containing high-voltage switchgear must be limited to 0.83 times the design pressure.

(i) *Location of high-voltage electrical components near flame paths*. High-voltage electrical components located in high-voltage explosion-proof enclosures must not be coplanar with a single plane flame-arresting path.

(j) *Minimum creepage distances*. Rigid insulation between high-voltage terminals (Phase-to-Phase or Phase-to-Ground) must be designed with creepage distances in accordance with the following table:

Phase-to-phase voltage	Points of measure	Minimum creepage distances (inches) for comparative tracking index (CTI) range ¹			
		CTI ≥ 500	380 ≤ CTI < 500	175 ≤ CTI < 380	CTI < 175
2,400	0-0	1.50	1.95	2.40	2.90
	0-G	1.00	1.25	1.55	1.85
4,160	0-0	2.40	3.15	3.90	4.65
	0-G	1.50	1.95	2.40	2.90

¹ Assumes that all insulation is rated for the applied voltage or higher.

(k) *Minimum free distances*. Motor-starter enclosures must be designed to establish the minimum free distance (MFD) between the wall or cover of the

enclosure and uninsulated electrical conductors inside the enclosure in accordance with the following table:

Wall/cover thickness (in)	Steel MFD (in)			Aluminum MFD (in)		
	A ¹	B ²	C ³	A ¹	B ²	C ³
1/4	2.8	4.3	5.8	⁴ NA	⁴ NA	⁴ NA
3/8	1.8	2.3	3.9	8.6	12.8	18.1
1/2	*1.2	2.0	2.7	6.5	9.8	13.0
5/8	*0.9	1.5	2.1	5.1	7.7	10.4
3/4	*0.6	*1.1	1.6	4.1	6.3	8.6
1	*	*0.6	*1.0	2.9	4.5	6.2

* Note: The minimum electrical clearances must still be maintained in accordance with the minimum clearance table of § 18.24.

¹ Column A specifies the MFD for enclosures that have available three-phase, bolted, short-circuit currents of 10,000 amperes root-mean-square (rms) value or less.

² Column B specifies the MFD for enclosures that have maximum available three-phase, bolted, short-circuit currents greater than 10,000 and less than or equal to 15,000 amperes rms.

³ Column C specifies the MFD for enclosures that have maximum available three-phase, bolted, short-circuit currents greater than 15,000 and less than or equal to 20,000 amperes rms.

⁴ Not Applicable—MSHA does not allow aluminum wall or covers to be 1/4 inch or less in thickness. (See also § 18.31.)

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(1) For values not included in the table, the following formulas, on which

the table is based, may be used to determine the minimum free distance.

(i) Steel Wall/Cover:

$$\text{MFD} = 2.296 \times 10^{-6} \frac{(35 + 105(C)) (I_{sc}) (t)}{(C) (d)} - \frac{d}{2}$$

(ii) Aluminum Wall/Cover:

$$\text{MFD} = 1.032 \times 10^{-5} \frac{(35 + 105(C)) (I_{sc}) (t)}{(C) (d)} - \frac{d}{2}$$

Where “C” is 1.4 for 2,400 volt systems or 3.0 for 4,160 volt systems; “ I_{sc} ” is the three-phase, short-circuit current in amperes of the system; “t” is the clearing time in seconds of the outby circuit-interrupting device; and “d” is the thickness in inches of the metal wall/cover adjacent to an area of potential arcing.

(2) The minimum free distance must be increased by 1.5 inches for 4,160 volt systems and 0.7 inches for 2,400 volt systems when the adjacent wall area is the top of the enclosure. If a steel shield is mounted in conjunction with an aluminum wall or cover, the thickness of the steel shield is used to determine the minimum free distances.

(1) *Static pressure testing of explosion-proof enclosures containing high-voltage switchgear.*

(1) *Prototype enclosures.* The following static pressure test must be performed on each prototype design of an explosion-proof enclosure containing high-voltage switchgear prior to the explosion tests.

(i) *Test procedure.*

(A) The enclosure must be internally pressurized to at least the design pressure, maintaining the pressure for a minimum of 10 seconds.

(B) Following the pressure hold, the pressure must be removed and the pressurizing agent removed from the enclosure.

(ii) *Acceptable performance.*

(A) During pressurization, the enclosure must not exhibit:

(1) Leakage through welds or casting; or

(2) Rupture of any part that affects the explosion-proof integrity of the enclosure.

(B) Following removal of the pressurizing agents, the enclosure must not exhibit:

(1) Cracks in welds visible to the naked eye;

(2) Permanent deformation exceeding 0.040 inches per linear foot; or

(3) Excessive clearances along flame-arresting paths following retightening of fastenings, as necessary.

(2) *Enclosures for production.* Every explosion-proof enclosure containing high-voltage switchgear manufactured after the prototype was tested must undergo one of the following tests or procedures:

(i) The static pressure test specified in paragraph (1)(1)(i) of this section; or

(ii) An MSHA-accepted quality assurance procedure covering inspection of the enclosure.

(A) The quality assurance procedure must include a detailed check of parts against the drawings to determine that—

(1) The parts and the drawings coincide; and

(2) The requirements stated in part 18 have been followed with respect to materials, dimensions, configuration and workmanship.

(B) [Reserved]

[75 FR 17547, Apr. 6, 2010]